IGCSE Biology 0610 (2026-2028) Revision Notes

Topic 11: Gas Exchange in Humans

This topic covers the structure, function, and mechanism of the human gas exchange system, as well as the composition of inspired and expired air.

11.1 Features of Gas Exchange Surfaces (Core 1)

Gas exchange surfaces, such as the alveoli in the lungs, are highly adapted to maximise the rate of diffusion of oxygen into the blood and carbon dioxide out of the blood. The key features are:

- **Large Surface Area:** Provided by the millions of alveoli, allowing for a large volume of gas to be exchanged.
- **Thin Surface:** The walls of the alveoli and capillaries are very thin (one cell thick), ensuring a **short diffusion distance**.
- **Good Blood Supply:** A dense network of capillaries surrounds the alveoli, which maintains a **steep concentration gradient** for gases.
- **Good Ventilation with Air:** The process of breathing constantly replaces the air in the alveoli, maintaining the **steep concentration gradient** for oxygen and carbon dioxide.

11.2 Structure and Function of the Gas Exchange System (Core 2 & Supplement 6, 7)

The human gas exchange system includes the following parts which you must be able to identify in diagrams and images: **lungs, diaphragm, ribs, intercostal muscles (internal and external), larynx, trachea, bronchi, bronchioles, alveoli, and associated capillaries.**

Role of Key Structures (Supplement 7)

- **Cartilage in the Trachea:** The trachea is supported by rings of cartilage. The function of this cartilage is to **prevent the trachea from collapsing** when the air pressure inside is low (e.g., during inhalation).

11.3 Mechanism of Ventilation (Supplement 8)

Ventilation (breathing) is the process of moving air into and out of the lungs. This is achieved by producing volume and pressure changes in the thorax (chest cavity).

Explain the role of the ribs, the internal and external intercostal muscles and the diaphragm in producing volume and pressure changes in the thorax leading to the ventilation of the lungs:

Process	Diaphragm	Intercostal Muscles	Ribs	Volume of Thorax	Pressure in Lungs	Air Move
Inhalation	Contracts (moves down and flattens).	**External** contract, **Internal** relax.	Move **up and out**.	**Increases**.	**Decreases** (below atmospheric pressure).	Air r **in**.
Exhalation	Relaxes (moves up into a dome shape).	**External** relax, **Internal** contract (during forced exhalation).	Move **down and in**.	**Decreases**.	**Increases** (above atmospheric pressure).	Air r **out**.

11.4 Composition of Inspired and Expired Air (Core 3, 4 & Supplement 9)

Core 3: Investigate the differences in composition between inspired and expired air using limewater as a test for carbon dioxide. When expired air is bubbled through limewater, it turns cloudy (milky). Inspired air does not turn limewater cloudy, or does so much more slowly. This demonstrates that **expired air contains a higher concentration of carbon dioxide** than inspired air.

Core 4 & Supplement 9: Describe/Explain the differences in composition between inspired and expired air, limited to: oxygen, carbon dioxide and water vapour.

Component	Inspired Air (Inhaled)	Expired Air (Exhaled)	Explanation (Supplement 9)
Oxygen (O_2)	$\approx 21\%$	$\approx 16\%$	Oxygen diffuses from the alveoli into the blood for aerobic respiration.
Carbon Dioxide (CO_2)	$\approx 0.04\%$	$\approx 4\%$	Carbon dioxide diffuses from the blood into the alveoli as a waste product of aerobic respiration.
Water Vapour	Variable (often low)	Saturated (high)	Air is humidified and warmed as it passes through the respiratory passages, and water is produced as a product of respiration.
Nitrogen (N_2)	$\approx 78\%$	$\approx 78\%$	Nitrogen is an inert gas and is not used or produced by the body.

11.5 Effects of Physical Activity (Core 5 & Supplement 10)

Core 5: Investigate and describe the effects of physical activity on the rate and depth of breathing. Physical activity causes a noticeable **increase in the rate and depth of breathing**.

Supplement 10: Explain the link between physical activity and the rate and depth of breathing in terms of: an increased carbon dioxide concentration in the blood, which is detected by the brain, leading to an increased rate and greater depth of breathing.

1. **Increased Respiration:** During physical activity, muscle cells respire faster to release more energy.
2. **Increased CO_2:** This increased respiration produces more waste **carbon dioxide (CO_2)**.
3. **Blood CO_2 Rises:** The concentration of CO_2 in the blood increases.

4. **Detection by Brain:** This rise in CO_2 concentration is detected by the **chemoreceptors in the brain** (specifically the medulla oblongata).
5. **Increased Ventilation:** The brain sends nerve impulses to the diaphragm and intercostal muscles, leading to an **increased rate and greater depth of breathing** to quickly remove the excess CO_2 and supply more O_2.

11.6 Protection of the Breathing System (Supplement 11)

Supplement 11: Explain the role of goblet cells, mucus and ciliated cells in protecting the breathing system from pathogens and particles.

Structure	Role in Protection
Goblet Cells	Produce **mucus**, a sticky substance that traps dust, bacteria, and other foreign particles inhaled with the air.
Mucus	Traps inhaled pathogens and particles, preventing them from reaching the delicate gas exchange surface of the alveoli.
Ciliated Cells	Have tiny hair-like projections called **cilia**. These cilia beat rhythmically upwards, sweeping the layer of mucus (and the trapped particles) up the trachea and into the pharynx, where it is swallowed or coughed out. This is known as the **mucus escalator**.

References

[1] Cambridge IGCSE Biology 0610/0970 Syllabus for examination in 2026, 2027 and 2028. (User-provided image)